

Introducing the Next Generation Science Standards

Leading Change Conference

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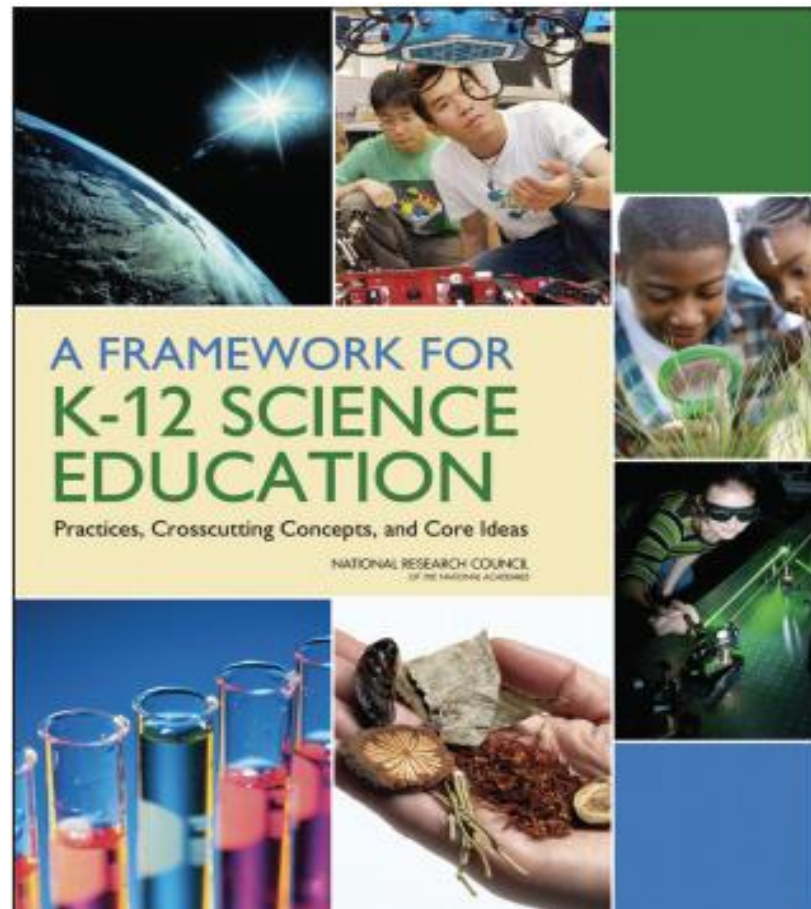
Overview for Today

Provide information about the NGSS

- standards development process
- reading and navigating the NGSS
- next steps for Arizona



The Framework outlines a vision of science learning that leads to a new vision of teaching.



Download the Framework for K-12 Science Education
http://www.nap.edu/catalog.php?record_id=13165

Structure of the Framework

The Framework for K-12 Science Education contains three dimensions:

- Scientific and Engineering Practices
- Disciplinary Core Ideas
- Crosscutting Concepts

Scientific and Engineering Practices

1. Asking questions and defining problems
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Developing explanations and designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Connect to ACCS Mathematics

Connect to ACCS ELA

Crosscutting Concepts

- Patterns, similarity, and diversity
- Cause and effect
- Scale, proportion and quantity
- Systems and system model
- Energy and matter
- Structure and function
- Stability and change

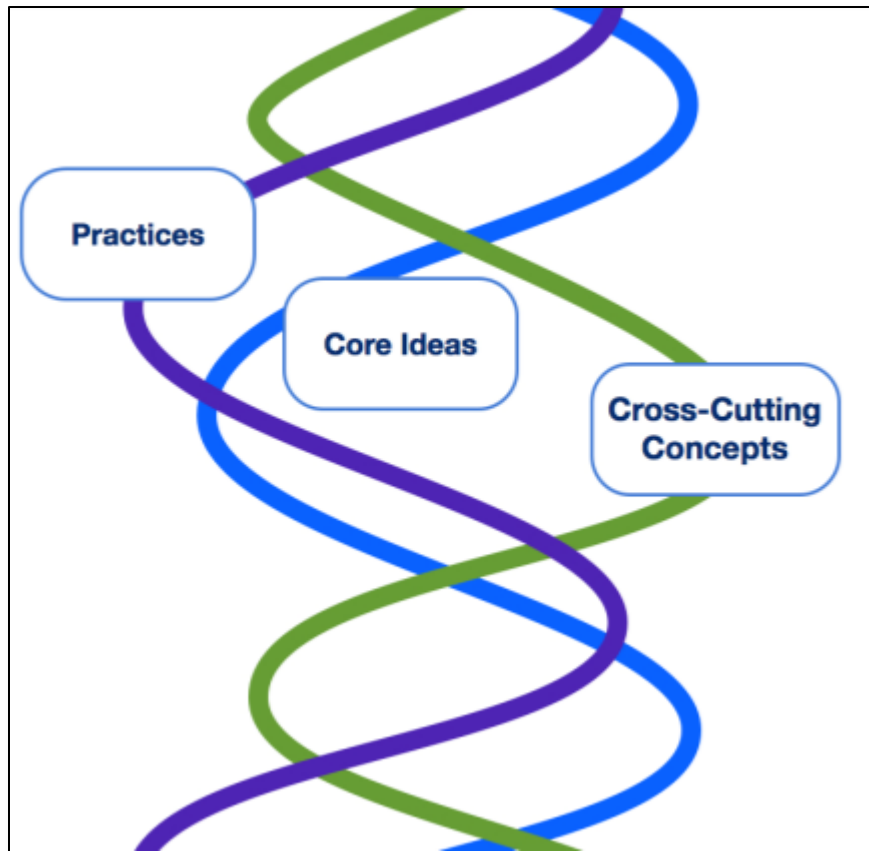
Provides conceptual framework to connect understandings into a coherent and scientifically-based view of the world

Disciplinary Core Ideas (DCIs)

Focus on the most important aspects of science across four domains:

- physical sciences
- life sciences
- Earth and space sciences
- engineering, technology and applications of science

Three Dimensions Intertwined



- Written as performance expectations (PEs)
- Require contextual application of the three dimensions

Shifts in the NGSS



1. Reflect the interconnected nature of science and engineering as it is practiced and experienced in the real world.
2. Provide student performance expectations, not curriculum
3. Build science concepts coherently from K-12
4. Focus on deeper understanding and application of content
5. Integrate science and engineering K-12
6. Prepare all students for college, career, and citizenship
7. Align with the Common Core State Standards (English Language Arts and Mathematics).

See [Appendix A](#) for more details



Next Generation Science Standards Final Release

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**Explore the
NGSS**

CURRENT PHASE

**The Next Generation Science
Standards are released**

[Explore the standards](#)

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About NGSS

Next Generation Science Standards for Today's Students and Tomorrow's Workforce: Through a collaborative, state-led process managed by Achieve, new K–12 science standards are being developed that will be rich in content and practice, arranged in a coherent manner across disciplines and grades to provide all students an internationally benchmarked science education. The NGSS will be based on the *Framework for K–12 Science Education* developed by the National Research Council.

Latest News

**Final Next Generation Science
Standards Released**

April 09, 2013

**Update on the Final Release of
the Next Generation Science
Standards**

March 28, 2013

**NSTA Statement on Release of
Second Public Draft of the Next
Generation Science Standards**

Resources



Watch a [webinar about the NGSS](#)

The Next Generation Science Standards

[Printer-friendly version](#)

The Next Generation Science Standards are now available. Twenty-six states and their broad-based teams worked together with a 41-member writing team and partners throughout the country to develop the standards.

[NGSS Front Matter](#)[NGSS Structure](#)[Appendices to the NGSS:](#)

- A. [Conceptual Shifts](#)
- B. [Responses to May Public Feedback](#)
- C. [College and Career Readiness \(Coming Soon\)](#)
- D. [All Standards, All Students \(Coming Soon\)](#)
- E. [Disciplinary Core Idea Progressions](#)
- F. [Science and Engineering Practices](#)
- G. [Crosscutting Concepts](#)
- H. [Nature of Science](#)
- I. [Engineering Design in the NGSS](#)
- J. [Science, Technology, Society, and the Environment](#)
- K. [Model Course Mapping in Middle and High School \(Coming Soon\)](#)
- L. [Connections to CESS-](#)

Download PDFs of the NGSS:

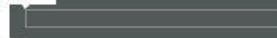
[Arranged by Disciplinary Core Idea \(DCI\)](#)[Arranged by Topic](#)

Interactive versions of the standards will be available soon.

The NGSS are composed of the **three dimensions** from the **NRC Framework**. Click on the links to the left to learn more about the standards



03:43



HD



vimeo

DCI Arrangement Coding



2-LS2 Ecosystems: Interactions, Energy, and Dynamics

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Students who demonstrate understanding can:

2-LS2-1. Plan and conduct an investigation to determine if plants need sunlight and water to grow. [Assessment Boundary: Assessment is limited to testing one variable at a time.]

2-LS2-2. Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.*

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Developing and Using Models

Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions.

- Develop a simple model based on evidence to represent a proposed object or tool. (2-LS2-2)

Planning and Carrying Out Investigations

Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.

- Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. (2-LS2-1)

Disciplinary Core Ideas

LS2.A: Interdependent Relationships in Ecosystems

- Plants depend on water and light to grow. (2-LS2-1)
- Plants depend on animals for pollination or to move their seeds around. (2-LS2-2)

ETS1.B: Developing Possible Solutions

- Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (secondary to 2-LS2-2)

Crosscutting Concepts

Cause and Effect

- Events have causes that generate observable patterns. (2-LS2-1)

Structure and Function

- The shape and stability of structures of natural and designed objects are related to their function(s). (2-LS2-2)

Connections to other DCIs in second grade: N/A

Articulation of DCIs across grade-bands: K.LS1.C (2-LS2-1); K.ESS3.A (2-LS2-1); K.ETS1.A (2-LS2-2); 5.LS1.C (2-LS2-1); 5.LS2.A (2-LS2-2)

Common Core State Standards Connections:

ELA/Literacy –

- W.2.7** Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations). (2-LS2-1)
- W.2.8** Recall information from experiences or gather information from provided sources to answer a question. (2-LS2-1)
- SL.2.5** Create audio recordings of stories or poems; add drawings or other visual displays to stories or recounts of experiences when appropriate to clarify ideas, thoughts, and feelings. (2-LS2-2)

Mathematics –

- MP.2** Reason abstractly and quantitatively. (2-LS2-1)
- MP.4** Model with mathematics. (2-LS2-1), (2-LS2-2)
- MP.5** Use appropriate tools strategically. (2-LS2-1)
- 2.MD.D.10** Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems. (2-LS2-2)

Topic Arrangement Coding



2.Interdependent Relationships in Ecosystems

2.Interdependent Relationships in Ecosystems

Students who demonstrate understanding can:

2-LS2-1. Plan and conduct an investigation to determine if plants need sunlight and water to grow. [Assessment Boundary: Assessment is limited to testing one variable at a time.]

2-LS2-2. Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.*

2-LS4-1. Make observations of plants and animals to compare the diversity of life in different habitats. [Clarification Statement: Emphasis is on the diversity of living things in each of a variety of different habitats.] [Assessment Boundary: Assessment does not include specific animal and plant names in specific habitats.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>Developing and Using Models Modeling in K-2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions.</p> <ul style="list-style-type: none"> Develop a simple model based on evidence to represent a proposed object or tool. (2-LS2-2) <p>Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K-2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.</p> <ul style="list-style-type: none"> Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. (2-LS2-1) Make observations (firsthand or from media) to collect data which can be used to make comparisons. (2-LS4-1) 	<p>LS2.A: Interdependent Relationships in Ecosystems</p> <ul style="list-style-type: none"> Plants depend on water and light to grow. (2-LS2-1) Plants depend on animals for pollination or to move their seeds around. (2-LS2-2) <p>LS4.D: Biodiversity and Humans</p> <ul style="list-style-type: none"> There are many different kinds of living things in any area, and they exist in different places on land and in water. (2-LS4-1) <p>ETS1.B: Developing Possible Solutions</p> <ul style="list-style-type: none"> Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (secondary to 2-LS2-2) 	<p>Cause and Effect</p> <ul style="list-style-type: none"> Events have causes that generate observable patterns. (2-LS2-1) <p>Structure and Function</p> <ul style="list-style-type: none"> The shape and stability of structures of natural and designed objects are related to their function(s). (2-LS2-2)

Connections to Nature of Science

Scientific Knowledge is Based on Empirical Evidence

- Scientists look for patterns and order when making observations about the world. (2-LS4-1)

Connections to other DCIs in second grade: N/A

Articulation of DCIs across grade-bands: K.LS1.C (2-LS2-1); K-ESS3.A (2-LS2-1); K.ETS1.A (2-LS2-2); 3.LS4.C (2-LS4-1); 3.LS4.D (2-LS4-1); 5.LS1.C (2-LS2-1); 5.LS2.A (2-LS2-2); (2-LS4-1)

Common Core State Standards Connections:

ELA/Literacy –

- W.2.7** Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations). (2-LS2-1),(2-LS4-1)
- W.2.8** Recall information from experiences or gather information from provided sources to answer a question. (2-LS2-1),(2-LS4-1)
- SL.2.5** Create audio recordings of stories or poems; add drawings or other visual displays to stories or recounts of experiences when appropriate to clarify ideas, thoughts, and feelings. (2-LS2-2)

Mathematics –

- MP.2** Reason abstractly and quantitatively. (2-LS2-1),(2-LS4-1)
- MP.4** Model with mathematics. (2-LS2-1),(2-LS2-2),(2-LS4-1)
- MP.5** Use appropriate tools strategically. (2-LS2-1)
- 2.MD.D.10** Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems. (2-LS2-2),(2-LS4-1)

Topic Arrangement Coding



Second Grade

The performance expectations in second grade help students formulate answers to questions such as: "How does land change and what are some things that cause it to change? What are the different kinds of land and bodies of water? How are materials similar and different from one another, and how do the properties of the materials relate to their use? What do plants need to grow? How many types of living things live in a place?" Second grade performance expectations include PS1, LS2, LS4, ESS1, ESS2, and ETS1 Disciplinary Core Ideas from the *NRC Framework*. Students are expected to develop an understanding of what plants need to grow and how plants depend on animals for seed dispersal and pollination. Students are also expected to compare the diversity of life in different habitats. An understanding of observable properties of materials is developed by students at this level through analysis and classification of different materials. Students are able to apply their understanding of the idea that wind and water can change the shape of the land to compare design solutions to slow or prevent such change. Students are able to use information and models to identify and represent the shapes and kinds of land and bodies of water in an area and where water is found on Earth. The crosscutting concepts of patterns; cause and effect; energy and matter; structure and function; stability and change; and influence of engineering, technology, and science on society and the natural world are called out as organizing concepts for these disciplinary core ideas. In the second grade performance expectations, students are expected to demonstrate grade-appropriate proficiency in developing and using models, planning and carrying out investigations, analyzing and interpreting data, constructing explanations and designing solutions, engaging in argument from evidence, and obtaining, evaluating, and communicating information. Students are expected to use these practices to demonstrate understanding of the core ideas.



Design of the Next Generation Science Standards

Key Design Considerations

- Topics are not intended to be units.
- Performance expectations are not sequential.
- Performance expectations indicate what all students need to know and be able to do at the end of instruction.
- Performance expectations do not indicate all the instructional steps (or materials) to get to that end.

1-ESS1 Earth's Place in the Universe

1-ESS1 Earth's Place in the Universe

Students who demonstrate understanding can:

1-ESS1-1. Use observations of the sun, moon, and stars to describe patterns that can be predicted. [Clarification Statement: Examples of patterns could include that the sun and moon appear to rise in one part of the sky, move across the sky, and set; and stars other than our sun are visible at night but not during the day.] [Assessment Boundary: Assessment of star patterns is limited to stars being seen at night and not during the day.]

1-ESS1-2. Make observations at different times of year to relate the amount of daylight to the time of year. [Clarification Statement: Emphasis is on relative comparisons of the amount of daylight in the winter to the amount in the spring or fall.] [Assessment Boundary: Assessment is limited to relative amounts of daylight, not quantifying the hours or time of daylight.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Planning and Carrying Out Investigations

Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.

- Make observations (firsthand or from media) to collect data that can be used to make comparisons. (1-ESS1-2)

Analyzing and Interpreting Data

Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.

- Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions. (1-ESS1-1)

Disciplinary Core Ideas

ESS1.A: The Universe and its Stars

- Patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted. (1-ESS1-1)

ESS1.B: Earth and the Solar System

- Seasonal patterns of sunrise and sunset can be observed, described, and predicted. (1-ESS1-2)

Crosscutting Concepts

Patterns

- Patterns in the natural world can be observed, used to describe phenomena, and used as evidence. (1-ESS1-1),(1-ESS1-2)

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Science assumes natural events happen today as they happened in the past. (1-ESS1-1)
- Many events are repeated. (1-ESS1-1)

Key Design Considerations

- PEs are not instructional tasks. The NGSS is designed to be a set of student performances ***after*** instruction.
- PEs were intentionally written at a conceptual level, leaving instructional procedures to states, districts, and teachers.
 - Assessment Boundary Statements provide further guidance or specify the scope of the expectation at a particular grade level for state-wide assessment.
 - Clarification Statements supply examples or additional clarification to the performance expectations.
- The intersection of the 3 dimensions is NOT intended to limit instruction or classroom assessment.

5-PS1 Matter and Its Interactions

5-PS1 Matter and Its Interactions

Students who demonstrate understanding can:

- 5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen.** [Clarification Statement: Examples of evidence could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water.] [Assessment Boundary: Assessment does not include the atomic-scale mechanism of evaporation and condensation or defining the unseen particles.]
- 5-PS1-2. Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.** [Clarification Statement: Examples of reactions or changes could include phase changes, dissolving, and mixing that forms new substances.] [Assessment Boundary: Assessment does not include distinguishing mass and weight.]
- 5-PS1-3. Make observations and measurements to identify materials based on their properties.** [Clarification Statement: Examples of materials to be identified could include baking soda and other powders, metals, minerals, and liquids. Examples of properties could include color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, and solubility; density is not intended as an identifiable property.] [Assessment Boundary: Assessment does not include density or distinguishing mass and weight.]
- 5-PS1-4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances.**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Key Design Considerations

Science and Engineering Practice Statements

- Derived from the eight practices in the *Framework*
- Explain the science and engineering practices important to emphasize in each grade band
- An individual PE only includes a single practice, but teachers are encouraged to embed several practices in their instruction.
 - The intent of the PE is to demonstrate the specific practice for which all students will be held accountable in state-wide assessments, not to limit instruction.
 - The intersection of the 3 dimensions is NOT intended to limit instruction or classroom assessment.

MS-ESS1 Earth's Place in the Universe

MS-ESS1 Earth's Place in the Universe

Students who demonstrate understanding can:

- MS-ESS1-1. Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.** [Clarification Statement: Examples of models can be physical, graphical, or conceptual.]
- MS-ESS1-2. Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.** [Clarification Statement: Emphasis for the model is on gravity as the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them. Examples of models can be physical (such as the analogy of distance along a football field or computer visualizations of elliptical orbits) or conceptual (such as mathematical proportions relative to the size of familiar objects such as their school or state).] [Assessment Boundary: Assessment does not include Kepler's Laws of orbital motion or the apparent retrograde motion of the planets as viewed from Earth.]
- MS-ESS1-3. Analyze and interpret data to determine scale properties of objects in the solar system.** [Clarification Statement: Emphasis is on the analysis of data from Earth-based instruments, space-based telescopes, and spacecraft to determine similarities and differences among solar system objects. Examples of scale properties include the sizes of an object's layers (such as crust and atmosphere), surface features (such as volcanoes), and orbital radius. Examples of data include statistical information, drawings and photographs, and models.] [Assessment Boundary: Assessment does not include recalling facts about properties of the planets and other solar system bodies.]
- MS-ESS1-4. Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.** [Clarification Statement: Emphasis is on how analyses of rock formations and the fossils they contain are used to establish relative ages of major events in Earth's history. Examples of Earth's major events could range from being very recent (such as the last Ice Age or the earliest fossils of homo sapiens) to very old (such as the formation of Earth or the earliest evidence of life). Examples can include the formation of mountain chains and ocean basins, the evolution or extinction of particular living organisms, or significant volcanic eruptions.] [Assessment Boundary: Assessment does not include recalling the names of specific periods or epochs and events within them.]

Practice 2 Developing and Using Models

Modeling can begin in the earliest grades, with students' models progressing from concrete "pictures" and/or physical scale models (e.g., a toy car) to more abstract representations of relevant relationships in later grades, such as a diagram representing forces on a particular object in a system. (NRC Framework, 2012, p. 58)

Models include diagrams, physical replicas, mathematical representations, analogies, and computer simulations. Although models do not correspond exactly to the real world, they bring certain features into focus while obscuring others. All models contain approximations and assumptions that limit the range of validity and predictive power, so it is important for students to recognize their limitations.

In science, models are used to represent a system (or parts of a system) under study, to aid in the development of questions and explanations, to generate data that can be used to make predictions, and to communicate ideas to others. Students can be expected to evaluate and refine models through an iterative cycle of comparing their predictions with the real world and then adjusting them to gain insights into the phenomenon being modeled. As such, models are based upon evidence. When new evidence is uncovered that the models can't explain, models are modified.

In engineering, models may be used to analyze a system to see where or under what conditions flaws might develop, or to test possible solutions to a problem. Models can also be used to visualize and refine a design, to communicate a design's features to others, and as prototypes for testing design performance.

Appendix F: Science and Engineering Practices / Matrix

Grades K-2	Grades 3-5	Grades 6-8	Grades 9-12
<p>Modeling in K-2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions.</p> <ul style="list-style-type: none"> Distinguish between a model and the actual object, process, and/or events the model represents. Compare models to identify common features and differences. Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s). Develop a simple model based on evidence to represent a proposed object or tool. 	<p>Modeling in 3-5 builds on K-2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.</p> <ul style="list-style-type: none"> Identify limitations of models. Collaboratively develop and/or revise a model based on evidence that shows the relationships among variables for frequent and regular occurring events. Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution. Develop and/or use models to describe and/or predict phenomena. Develop a diagram or simple physical prototype to convey a proposed object, tool, or process. Use a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system. 	<p>Modeling in 6-8 builds on K-5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.</p> <ul style="list-style-type: none"> Evaluate limitations of a model for a proposed object or tool. Develop or modify a model—based on evidence—to match what happens if a variable or component of a system is changed. Use and/or develop a model of simple systems with uncertain and less predictable factors. Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena. Develop and/or use a model to predict and/or describe phenomena. Develop a model to describe unobservable mechanisms. Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales. 	<p>Modeling in 9-12 builds on K-8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.</p> <ul style="list-style-type: none"> Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism or system, in order to select or revise a model that best fits the evidence or design criteria. Design a test of a model to ascertain its reliability. Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations. Develop a complex model that allows for manipulation and testing of a proposed process or system. Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.

Key Design Considerations

Disciplinary Core Ideas (DCIs)

- Included verbatim from the *Framework*
- The core idea is the conceptual culmination of the learning progression for that grade/grade band; it does not include all content and skills the student must learn to get to that end point.
- The intersection of the 3 dimensions is NOT intended to limit instruction or classroom assessment.

MS-ESS1 Earth's Place in the Universe

MS-ESS1 Earth's Place in the Universe

Students who demonstrate understanding can:

- MS-ESS1-1. Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.** [Clarification Statement: Examples of models can be physical, graphical, or conceptual.]
- MS-ESS1-2. Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.** [Clarification Statement: Emphasis for the model is on gravity as the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them. Examples of models can be physical (such as the analogy of distance along a football field or computer visualizations of elliptical orbits) or conceptual (such as mathematical proportions relative to the size of familiar objects such as their school or state).] [Assessment Boundary: Assessment does not include Kepler's Laws of orbital motion or the apparent retrograde motion of the planets as viewed from Earth.]
- MS-ESS1-3. Analyze and interpret data to determine scale properties of objects in the solar system.** [Clarification Statement: Emphasis is on the analysis of data from Earth-based instruments, space-based telescopes, and spacecraft to determine similarities and differences among solar system objects. Examples of scale properties include the sizes of an object's layers (such as crust and atmosphere), surface features (such as volcanoes), and orbital radius. Examples of data include statistical information, drawings and photographs, and models.] [Assessment Boundary: Assessment does not include recalling facts about properties of the planets and other solar system bodies.]
- MS-ESS1-4. Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.** [Clarification Statement: Emphasis is on how analyses of rock formations and the fossils they contain are used to establish relative ages of major events in Earth's history. Examples of Earth's major events could range from being very recent (such as the last Ice Age or the earliest fossils of homo sapiens) to very old (such as the formation of Earth or the earliest evidence of life). Examples can include the formation of mountain chains and ocean basins, the evolution or extinction of particular living organisms, or significant volcanic eruptions.] [Assessment Boundary: Assessment does not include recalling the names of specific periods or epochs and events within them.]

Appendix E: DCI Progressions



Earth Space Science Progression

INCREASING SOPHISTICATION OF STUDENT THINKING

	K-2	3-5	6-8	9-12
ESS1.A The universe and its stars	Patterns of movement of the sun, moon, and stars as seen from Earth can be observed, described, and predicted.	Stars range greatly in size and distance from Earth and this can explain their relative brightness.		Light spectra from stars are used to determine their characteristics, processes, and lifecycles. Solar activity creates the elements through nuclear fusion, and short-term solar variations cause space weather and insolation changes that significantly affect humanity. The development of technologies has provided the astronomical data that provide the empirical evidence for the Big Bang theory.
ESS1.B Earth and the solar system		The Earth's orbit and rotation, and the orbit of the moon around the Earth cause observable patterns.	The solar system is part of the Milky Way, which is one of many billions of galaxies.	
ESS1.C The history of planet Earth	Some events on Earth occur very quickly; others can occur very slowly.	Certain features on Earth can be used to order events that have occurred in a landscape.	Rock strata and the fossil record can be used as evidence to organize the relative occurrence of major historical events in Earth's history.	Kepler's laws describe common features of the motions of orbiting objects. Observations from astronomy and space probes provide evidence for explanations of solar system formation. Changes in Earth's tilt and orbit cause climate changes such as Ice Ages.
ESS2.A Earth materials and systems	Wind and water change the shape of the land.	Four major Earth systems interact. Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, organisms, and gravity break rocks, soils, and sediments into smaller pieces and move them around.	Energy flows and matter cycles within and among Earth's systems, including the sun and Earth's interior as primary energy sources. Plate tectonics is one result of these processes.	The rock record resulting from tectonic and other geoscience processes as well as objects from the solar system can provide evidence of Earth's early history and the relative ages of major geologic formations.
ESS2.B Plate tectonics and large-scale system interactions	Maps show where things are located. One can map the shapes and kinds of land and water in any area.	Earth's physical features occur in patterns, as do earthquakes and volcanoes. Maps can be used to locate features and determine patterns in those events.	Plate tectonics is the unifying theory that explains movements of rocks at Earth's surface and geological history. Maps are used to display evidence of plate movement.	Feedback effects exist within and among Earth's systems. Radioactive decay and residual heat of formation within Earth's interior contribute to thermal convection in the mantle.

Key Design Considerations

Crosscutting Concept Statements

- Derived from the *Framework*
- Explain the crosscutting concepts important to emphasize in each grade band.
- An individual PE only includes a single crosscutting concept, but teachers are encouraged to make other connections.
 - The intent of the PE is to demonstrate the specific CCC for which students will be held accountable in state-wide assessments, not to limit instruction.
 - Aspects of the Nature of Science are included but are not additional content. They are meant to show how the NOS applies to specific PEs.
 - The intersection of the 3 dimensions is NOT intended to limit instruction or classroom (formative and summative) assessment.

MS-ESS1 Earth's Place in the Universe

MS-ESS1 Earth's Place in the Universe

Students who demonstrate understanding can:

- MS-ESS1-1. Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.** [Clarification Statement: Examples of models can be physical, graphical, or conceptual.]
- MS-ESS1-2. Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.** [Clarification Statement: Emphasis for the model is on gravity as the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them. Examples of models can be physical (such as the analogy of distance along a football field or computer visualizations of elliptical orbits) or conceptual (such as mathematical proportions relative to the size of familiar objects such as their school or state).] [Assessment Boundary: Assessment does not include Kepler's Laws of orbital motion or the apparent retrograde motion of the planets as viewed from Earth.]
- MS-ESS1-3. Analyze and interpret data to determine scale properties of objects in the solar system.** [Clarification Statement: Emphasis is on the analysis of data from Earth-based instruments, space-based telescopes, and spacecraft to determine similarities and differences among solar system objects. Examples of scale properties include the sizes of an object's layers (such as crust and atmosphere), surface features (such as volcanoes), and orbital radius. Examples of data include statistical information, drawings and photographs, and models.] [Assessment Boundary: Assessment does not include recalling facts about properties of the planets and other solar system bodies.]
- MS-ESS1-4. Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.** [Clarification Statement: Emphasis is on how analyses of rock formations and the fossils they contain are used to establish relative ages of major events in Earth's history. Examples of Earth's major events could range from being very recent (such as the last Ice Age or the earliest fossils of homo sapiens) to very old (such as the formation of Earth or the earliest evidence of life). Examples can include the formation of mountain chains and ocean basins, the evolution or extinction of particular living organisms, or significant volcanic eruptions.] [Assessment Boundary: Assessment does not include recalling the names of specific periods or epochs and events within them.]

Appendix G: Crosscutting Concepts / Matrix

NGSS Crosscutting Concepts*

3. Scale, Proportion, and Quantity – In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.			
K-2 Crosscutting Statements	3-5 Crosscutting Statements	6-8 Crosscutting Statements	9-12 Crosscutting Statements
<ul style="list-style-type: none"> Relative scales allow objects and events to be compared and described (e.g., bigger and smaller; hotter and colder; faster and slower). Standard units are used to measure length. 	<ul style="list-style-type: none"> Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods. Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. 	<ul style="list-style-type: none"> Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. The observed function of natural and designed systems may change with scale. Proportional relationships (e.g., speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. Scientific relationships can be represented through the use of algebraic expressions and equations. Phenomena that can be observed at one scale may not be observable at another scale. 	<ul style="list-style-type: none"> The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. Some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly. Patterns observable at one scale may not be observable or exist at other scales. Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).
4. Systems and System Models – A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.			
K-2 Crosscutting Statements	3-5 Crosscutting Statements	6-8 Crosscutting Statements	9-12 Crosscutting Statements
<ul style="list-style-type: none"> Objects and organisms can be described in terms of their parts. Systems in the natural and designed world have parts that work together. 	<ul style="list-style-type: none"> A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot. A system can be described in terms of its components and their interactions. 	<ul style="list-style-type: none"> Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. Models are limited in that they only represent certain aspects of the system under study. 	<ul style="list-style-type: none"> Systems can be designed to do specific tasks. When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.



Appendices and Supplementary Documents

Appendix Documents



- Appendices have been added to support the NGSS in response to feedback
 - Appendix A – Conceptual Shifts
 - Appendix B – Responses to May Public Feedback
 - Appendix C – College and Career Readiness (Coming Soon)
 - Appendix D – All Standards, All Students
 - Appendix E – Disciplinary Core Idea Progressions
 - Appendix F – Science and Engineering Practices
 - Appendix G – Crosscutting Concepts
 - Appendix H – Nature of Science
 - Appendix I – Engineering Design in the NGSS
 - Appendix J – Science, Technology, Society, and the Environment
 - Appendix K – Model Course Mapping in Middle and High School (Coming Soon)
 - Appendix L – Connections to CCSS-Mathematics
 - Appendix M – Connections to CCSS-ELA Literacy

Appendix D – All Standards, All Students



Case studies represent science disciplines across grade levels (coming soon):

- economically disadvantaged students – 9th grade chemistry
- students from major racial and ethnic groups – 8th grade life science
- students with disabilities – 6th grade space science
- students with limited English proficiency – 2nd grade earth science
- gender – 3rd grade engineering
- students in alternative education programs – 10th and 11th grade chemistry
- gifted and talented students – 4th grade life science

Appendix H: Nature of Science

Overview

One goal of science education is to help students understand the nature of scientific knowledge. This matrix presents eight major themes and grade level understandings about the nature of science. Four themes extend the scientific and engineering practices and four themes extend the crosscutting concepts. These eight themes are presented in the left column. The matrix describes learning outcomes for the themes at grade bands for K-2, 3-5, middle school, and high school. Appropriate learning outcomes are expressed in selected performance expectations and presented in the foundation boxes throughout the standards.

Understandings about the Nature of Science

Categories	K-2	3-5	Middle School	High School
Scientific Investigations Use a Variety of Methods	<ul style="list-style-type: none"> Science investigations begin with a question. Science uses different ways to study the world. 	<ul style="list-style-type: none"> Science methods are determined by questions. Science investigations use a variety of methods, tools, and techniques. 	<ul style="list-style-type: none"> Science investigations use a variety of methods and tools to make measurements and observations. Science investigations are guided by a set of values to ensure accuracy of measurements, observations, and objectivity of findings. Science depends on evaluating proposed explanations. Scientific values function as criteria in distinguishing between science and non-science. 	<ul style="list-style-type: none"> Science investigations use diverse methods and do not always use the same set of procedures to obtain data. New technologies advance scientific knowledge. Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. The discourse practices of science are organized around disciplinary domains that share exemplars for making decisions regarding the values, instruments, methods, models, and evidence to adopt and use. Scientific investigations use a variety of methods, tools, and techniques to revise and produce new knowledge.
Scientific Knowledge is Based on Empirical Evidence	<ul style="list-style-type: none"> Scientists look for patterns and order when making observations about the world. 	<ul style="list-style-type: none"> Science findings are based on recognizing patterns. Science uses tools and technologies to make accurate measurements and observations. 	<ul style="list-style-type: none"> Science knowledge is based upon logical and conceptual connections between evidence and explanations. Science disciplines share common rules of obtaining and evaluating empirical evidence. 	<ul style="list-style-type: none"> Science knowledge is based on empirical evidence. Science disciplines share common rules of evidence used to evaluate explanations about natural systems. Science includes the process of coordinating patterns of evidence with current theory. Science arguments are strengthened by multiple lines of evidence supporting a single explanation.
Scientific Knowledge is Open to Revision in Light of New Evidence	<ul style="list-style-type: none"> Science knowledge can change when new information is found. 	<ul style="list-style-type: none"> Science explanations can change based on new evidence. 	<ul style="list-style-type: none"> Scientific explanations are subject to revision and improvement in light of new evidence. The certainty and durability of science findings varies. Science findings are frequently revised and/or reinterpreted based on new evidence. 	<ul style="list-style-type: none"> Scientific explanations can be probabilistic. Most scientific knowledge is quite durable but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation.
Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena	<ul style="list-style-type: none"> Science uses drawings, sketches, and models as a way to communicate ideas. Science searches for cause and effect relationships to explain natural events. 	<ul style="list-style-type: none"> Science theories are based on a body of evidence and many tests. Science explanations describe the mechanisms for natural events. 	<ul style="list-style-type: none"> Theories are explanations for observable phenomena. Science theories are based on a body of evidence developed over time. Laws are regularities or mathematical descriptions of natural phenomena. A hypothesis is used by scientists as an idea that may contribute important new knowledge for the evaluation of a scientific theory. The term "theory" as used in science is very different from the common use outside of science. 	<ul style="list-style-type: none"> Theories and laws provide explanations in science, but theories do not with time become laws or facts. A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that has been repeatedly confirmed through observation and experiment, and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. Models, mechanisms, and explanations collectively serve as tools in the development of a scientific theory. Laws are statements or descriptions of the relationships among observable phenomena. Scientists often use hypotheses to develop and test theories and explanations.

2. Interdependent Relationships in Ecosystems

2. Interdependent Relationships in Ecosystems

Students who demonstrate understanding can:

2-LS2-1. Plan and conduct an investigation to determine if plants need sunlight and water to grow. [Assessment Boundary: Assessment is limited to testing one variable at a time.]

2-LS2-2. Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.*

2-LS4-1. Make observations of plants and animals to compare the diversity of life in different habitats. [Clarification Statement: Emphasis is on the diversity of living things in each of a variety of different habitats.] [Assessment Boundary: Assessment does not include specific animal and plant names in specific habitats.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Developing and Using Models

Modeling in K-2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions.

- Develop a simple model based on evidence to represent a proposed object or tool. (2-LS2-2)

Planning and Carrying Out Investigations

Planning and carrying out investigations to answer questions or test solutions to problems in K-2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.

- Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. (2-LS2-1)
- Make observations (firsthand or from media) to collect data which can be used to make comparisons. (2-LS4-1)

Connections to Nature of Science

Scientific Knowledge is Based on Empirical Evidence

- Scientists look for patterns and order when making observations about the world. (2-LS4-1)

Disciplinary Core Ideas

LS2.A: Interdependent Relationships in Ecosystems

- Plants depend on water and light to grow. (2-LS2-1)
- Plants depend on animals for pollination or to move their seeds around. (2-LS2-2)

LS4.D: Biodiversity and Humans

- There are many different kinds of living things in any area, and they exist in different places on land and in water. (2-LS4-1)

ETS1.B: Developing Possible Solutions

- Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (secondary to 2-LS2-2)

Crosscutting Concepts

Cause and Effect

- Events have causes that generate observable patterns. (2-LS2-1)

Structure and Function

- The shape and stability of structures of natural and designed objects are related to their function(s). (2-LS2-2)

Connections to other DCIs in second grade: N/A

Articulation of DCIs across grade-bands: K.LS1.C (2-LS2-1); K.ESS3.A (2-LS2-1); K.ETS1.A (2-LS2-2); 3.LS4.C (2-LS4-1); 3.LS4.D (2-LS4-1); 5.LS1.C (2-LS2-1); 5.LS2.A (2-LS2-2); (2-LS4-1)

Common Core State Standards Connections:

ELA/Literacy –

- W.2.7** Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations). (2-LS2-1), (2-LS4-1)
- W.2.8** Recall information from experiences or gather information from provided sources to answer a question. (2-LS2-1), (2-LS4-1)
- SL.2.5** Create audio recordings of stories or poems; add drawings or other visual displays to stories or recounts of experiences when appropriate to clarify ideas, thoughts, and feelings. (2-LS2-2)

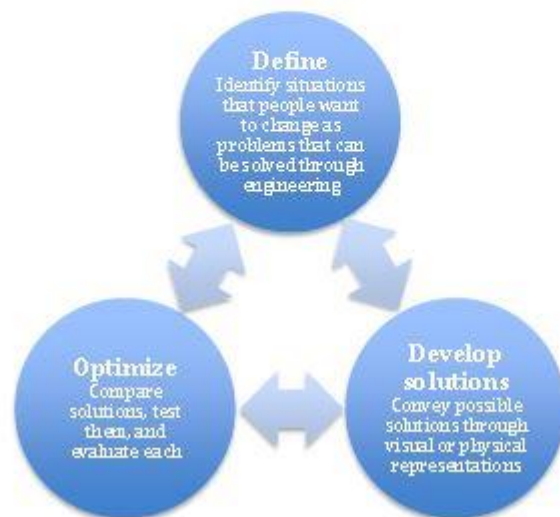
Mathematics –

- MP.2** Reason abstractly and quantitatively. (2-LS2-1), (2-LS4-1)
- MP.4** Model with mathematics. (2-LS2-1), (2-LS2-2), (2-LS4-1)
- MP.5** Use appropriate tools strategically. (2-LS2-1)
- 2.MD.D.10** Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems. (2-LS2-2), (2-LS4-1)

Appendix I: Engineering Design in the NGSS

Grades K-2

Engineering design in the earliest grades introduces students to “problems” as situations that people want to change. They can use tools and materials to solve simple problems, use different representations to convey solutions, and compare different solutions to a problem and determine which is best. Students in all grade levels are not expected to come up with original solutions, although original solutions are always welcome. Emphasis is on thinking through the needs or goals that need to be met, and which solutions best meet those needs and goals.



century society.

Performance Expectations That Incorporate Engineering Practices

	Physical Science	Life Science	Earth and Space Science	Engineering
K	K-PS2-2 K-PS3-2		K-ESS3-2 K-ESS3-3	K-2-ETS1-1 K-2-ETS1-2 K-2-ETS1-3
1	1-PS4-4	1-LS1-1		
2	2-PS1-2	2-LS2-2	2-ESS2-1	
3	3-PS2-4	3-LS4-4	3-ESS3-1	3-5-ETS1-1

K-PS2 Motion and Stability: Forces and Interactions

K-PS2 Motion and Stability: Forces and interactions

Students who demonstrate understanding can:

K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object. [Clarification Statement: Examples of pushes or pulls could include a string attached to an object being pulled, a person pushing an object, a person stopping a rolling ball, and two objects colliding and pushing on each other.] [Assessment Boundary: Assessment is limited to different relative strengths or different directions, but not both at the same time. Assessment does not include non-contact pushes or pulls such as those produced by magnets.]

K-PS2-2. Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.* [Clarification Statement: Examples of problems requiring a solution could include having a marble or other object move a certain distance, follow a particular path, and knock down other objects. Examples of solutions could include tools such as a ramp to increase the speed of the object and a structure that would cause an object such as a marble or ball to turn.] [Assessment Boundary: Assessment does not include friction as a mechanism for change in speed.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*.

Science and Engineering Practices

Planning and Carrying Out Investigations

Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.

- With guidance, plan and conduct an investigation in collaboration with peers. (K-PS2-1)

Analyzing and Interpreting Data

Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.

- Analyze data from tests of an object or tool to determine if it works as intended. (K-PS2-2)

Connections to Nature of Science

Scientific Investigations Use a Variety of Methods

- Science uses different ways to study the world. (K-PS2-1)

Disciplinary Core Ideas

PS2.A: Forces and Motion

- Pushes and pulls can have different strengths and directions. (K-PS2-1),(K-PS2-2)
- Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. (K-PS2-1),(K-PS2-2)

PS2.B: Types of Interactions

- When objects touch or collide, they push on one another and can change motion. (K-PS2-1)

PS3.C: Relationship Between Energy and Forces

- A bigger push or pull makes things go faster. (*secondary to K-PS2-1*)

ETS1.A: Defining Engineering Problems

- A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. (*secondary to K-PS2-2*)

Crosscutting Concepts

Cause and Effect

- Simple tests can be designed to gather evidence to support or refute student ideas about causes. (K-PS2-1),(K-PS2-2)

Appendix J: Science, Technology, Society, and the Environment

The following matrix summarizes how the two core ideas discussed in this chapter progress across the grade levels.

<i>1. Interdependence of Science, Engineering, and Technology</i>			
K-2 Connections Statements	3-5 Connections Statements	6-8 Connections Statements	9-12 Connections Statements
<ul style="list-style-type: none">Science and engineering involve the use of tools to observe and measure things.	<ul style="list-style-type: none">Science and technology support each other.Tools and instruments are used to answer scientific questions, while scientific discoveries lead to the development of new technologies.	<ul style="list-style-type: none">Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems.Science and technology drive each other forward.	<ul style="list-style-type: none">Science and engineering complement each other in the cycle known as research and development (R&D).Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.

<i>2. Influence of Engineering, Technology, and Science on Society and the Natural World</i>			
K-2 Connections Statements	3-5 Connections Statements	6-8 Connections Statements	9-12 Connections Statements
<ul style="list-style-type: none">Every human-made	<ul style="list-style-type: none">People's needs and	<ul style="list-style-type: none">All human activity draws on	<ul style="list-style-type: none">Modern civilization depends on

Appendix K: Model Course Mapping in Middle and High School (coming soon)

Modified Science Domains Model (9-12)

Biology

LS1.A	HS-LS1-a
	HS-LS1-b
	HS-LS1-c
	HS-LS1-d
LS1.B	HS-LS1-e
	HS-LS1-f
	HS-LS1-g
	HS-LS1-h
LS1.C	HS-LS1-i
	HS-LS1-j
	HS-LS2-d
	HS-LS2-g
	HS-LS2-e
	HS-LS2-c
LS1.D	HS-LS1-k
LS2.A	HS-LS1-l
	HS-LS2-a
LS2.B	HS-LS2-b
	HS-LS1-i
	HS-LS1-j
	HS-LS2-d
	HS-LS2-g
	HS-LS2-e
LS2.C	HS-LS2-f
	HS-LS2-h
	HS-LS2-i
	HS-LS2-j
LS2.D	HS-LS2-k
LS3.A	HS-LS3-a
	HS-LS3-b
LS4.A	HS-LS3-d
	HS-LS4-f
	HS-LS4-b
	HS-LS4-d
LS4.B	HS-LS4-c
	HS-LS4-e
	HS-LS4-b
	HS-LS4-d
LS4.C	HS-LS4-c
	HS-LS4-e
	HS-LS4-a
LS4.D	HS-LS2-l
ESS1.C	HS-ESS1-g
	HS-ESS1-i
	HS-ESS1-j
	HS-ESS1-h
ESS2.E	HS-ESS1-l
ESS3.B	HS-ESS3-c
	HS-ESS3-d
ESS3.C	HS-ESS3-e
	HS-ESS3-f

Chemistry

PS1.A	HS-PS1-a
	HS-PS1-b
	HS-PS1-c
	HS-PS2-f
	HS-PS1-d
	HS-PS1-j
PS1.B	HS-PS3-g
	HS-PS1-e
	HS-PS1-f
	HS-PS1-g
	HS-PS1-h
PS2.C	HS-PS1-i
PS3.B	HS-PS1-g
PS3.D	HS-PS3-d
ESS2.C	HS-ESS2-i
ESS2.D	HS-ESS2-j
	HS-ESS2-k
	HS-ESS2-e
	HS-ESS2-f
	HS-ESS2-g
ESS3.A	HS-ESS3-h
	HS-ESS3-a
	HS-ESS3-b
ESS3.D	HS-ESS3-i
	HS-ESS3-g
	HS-ESS3-h

Physics

PS2.A	HS-PS2-a
	HS-PS2-b
	HS-PS2-c
PS2.B	HS-PS2-d
PS2.C	HS-PS2-e
	HS-PS1-g
	HS-PS2-b
PS3.A	HS-PS2-c
	HS-PS3-a
	HS-PS3-b
PS3.B	HS-PS3-c
	HS-PS3-a
	HS-PS3-b
PS3.C	HS-PS3-d
	HS-PS3-f
	HS-PS3-e
PS4.A	HS-PS4-a
	HS-PS4-b
	HS-PS4-c
	HS-PS4-d
PS4.B	HS-PS4-a
	HS-PS4-e
	HS-PS4-f
	HS-PS4-g
ESS1.A	HS-PS4-h
	HS-ESS1-b
	HS-ESS1-c
	HS-ESS1-a
ESS1.B	HS-ESS1-d
	HS-ESS1-e
	HS-ESS1-f
	HS-ESS2-c
ESS2.A	HS-ESS2-d
	HS-ESS2-a
	HS-ESS2-b
	HS-ESS2-e
	HS-ESS2-f
	HS-ESS2-g
	HS-ESS2-h
ESS2.B	HS-ESS2-d
	HS-ESS2-a
	HS-ESS1-h

KEY

	PE appears in more than one DCI in the same course.
	PE shared across more than one course because a component idea is divided between courses.
	PE appears in more than one course and it is connected to more than one DCI component idea in the same course.

Appendix L: Connections to Common Core Mathematics (coming soon)



5.ESP Earth Surface Processes

As part of this work, teachers should give students opportunities to **use the coordinate plane**:

5.G.2. Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation. *Science example: Plot monthly data for high and low temperatures in two locations, one coastal and one inland (e.g., San Francisco County vs. Sacramento). What patterns do you see? How can the influence of the ocean be seen in the observed patterns?*

Alignment notes: (1) Trends in scatterplots and patterns of association in two-way tables are not expected until Grade 8.

5.SS Space Systems: Stars and the Solar System

As part of this work, teachers should give students opportunities to **use the coordinate plane**:

5.G.2. Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation. *Science examples: (1) Over the course of a year, students compile data for the length of the day over the course of the year. What pattern is observed when the data are graphed on a coordinate plane, and how can a model of the sun and Earth explain the pattern? (2) Students are given (x,y) coordinates for the Earth at six equally spaced times during its orbit around the sun (with the sun at the origin). Students graph the points to show snapshots of Earth's motion through space.*



**What questions do you
have about the NGSS
documents?**



What's Next for Arizona?

NGSS Released April 9, 2013

Now what?



The State Board of Education must adopt the NGSS before they become Arizona's Science Standards.

1. Review complete standards and appendix documents.
2. Determine PD needs and support materials needed for implementation.
3. Determine adoption and implementation timeline.
4. Determine assessment requirements and assessment timeline. (Anticipate current AIMS science through Spring 2016, possibly longer)
5. Collect feedback and determine support for adoption.

Issues to Address before Adoption

- How will grade band standards be addressed in middle and high school?
 - All standards, all students!
- Will decisions impact certification requirements?
- Which grades will be assessed?
 - All standards, all students?
- What will the assessment look like?

Changes to make for 2013/14



Adjust instruction of 2004 Arizona Science Standard to meet vision of Framework/NGSS

1. Emphasize the interconnected nature of science and engineering as it is practiced and experienced in the real world.
2. Provide student performance expectations, not curriculum
3. Build science concepts coherently from K-12
4. Focus on deeper understanding and application of content
5. Integrate science and engineering K-12
6. Prepare all students for college, career, and citizenship
7. Integrate Arizona's Common Core Standards (English Language Arts and Mathematics).

See [Appendix A](#) for more details

K-PS2 Motion and Stability: Forces and Interactions

K-PS2 Motion and Stability: Forces and interactions

Students who demonstrate understanding can:

- K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.** [Clarification Statement: Examples of pushes or pulls could include a string attached to an object being pulled, a person pushing an object, a person stopping a rolling ball, and two objects colliding and pushing on each other.] [Assessment Boundary: Assessment is limited to different relative strengths or different directions, but not both at the same time. Assessment does not include non-contact pushes or pulls such as those produced by magnets.]
- K-PS2-2. Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.*** [Clarification Statement: Examples of problems requiring a solution could include having a marble or other object move a certain distance, follow a particular path, and knock down other objects. Examples of solutions could include tools such as a ramp to increase the speed of the object and a structure that would cause an object such as a marble or ball to turn.] [Assessment Boundary: Assessment does not include friction as a mechanism for change in speed.]

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Science and Engineering Practices

Planning and Carrying Out Investigations

Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.

- With guidance, plan and conduct an investigation in collaboration with peers. (K-PS2-1)

Analyzing and Interpreting Data

Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.

- Analyze data from tests of an object or tool to determine if it works as intended. (K-PS2-2)

Connections to Nature of Science

Scientific Investigations Use a Variety of Methods

- Science uses different ways to study the world. (K-PS2-1)

Disciplinary Core Ideas

PS2.A: Forces and Motion

- Pushes and pulls can have different strengths and directions. (K-PS2-1),(K-PS2-2)
- Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. (K-PS2-1),(K-PS2-2)

PS2.B: Types of Interactions

- When objects touch or collide, they push on one another and can change motion. (K-PS2-1)

PS3.C: Relationship Between Energy and Forces

- A bigger push or pull makes things go faster. (*secondary to K-PS2-1*)

ETS1.A: Defining Engineering Problems

- A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. (*secondary to K-PS2-2*)

Crosscutting Concepts

Cause and Effect

- Simple tests can be designed to gather evidence to support or refute student ideas about causes. (K-PS2-1),(K-PS2-2)

SC00-S5C3: Energy and Magnetism Investigate different forms of energy.

PO 1. Investigate how applied forces (push and pull) can make things move.

1-ESS1 Earth's Place in the Universe

1-ESS1 Earth's Place in the Universe

Students who demonstrate understanding can:

1-ESS1-1. Use observations of the sun, moon, and stars to describe patterns that can be predicted. [Clarification Statement: Examples of patterns could include that the sun and moon appear to rise in one part of the sky, move across the sky, and set; and stars other than our sun are visible at night but not during the day.] [Assessment Boundary: Assessment of star patterns is limited to stars being seen at night and not during the day.]

1-ESS1-2. Make observations at different times of year to relate the amount of daylight to the time of year. [Clarification Statement: Emphasis is on relative comparisons of the amount of daylight in the winter to the amount in the spring or fall.] [Assessment Boundary: Assessment is limited to relative amounts of daylight, not quantifying the hours or time of daylight.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.</p> <ul style="list-style-type: none"> Make observations (firsthand or from media) to collect data that can be used to make comparisons. (1-ESS1-2) <p>Analyzing and Interpreting Data Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.</p> <ul style="list-style-type: none"> Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions. (1-ESS1-1) 	<p>ESS1.A: The Universe and its Stars</p> <ul style="list-style-type: none"> Patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted. (1-ESS1-1) <p>ESS1.B: Earth and the Solar System</p> <ul style="list-style-type: none"> Seasonal patterns of sunrise and sunset can be observed, described, and predicted. (1-ESS1-2) 	<p>Patterns</p> <ul style="list-style-type: none"> Patterns in the natural world can be observed, used to describe phenomena, and used as evidence. (1-ESS1-1),(1-ESS1-2) <p>-----</p> <p>Connections to Nature of Science</p> <p>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</p> <ul style="list-style-type: none"> Science assumes natural events happen today as they happened in the past. (1-ESS1-1) Many events are repeated. (1-ESS1-1)

SC01-S6C2: Objects in the Sky Identify objects in the sky.

PO 1. Identify evidence that the Sun is the natural source of heat and light on the Earth (e.g., warm surfaces, shadows, shade).

PO 2. Compare celestial objects (e.g., Sun, Moon, stars) and transient objects in the sky (e.g., clouds, birds, airplanes, contrails).

PO 3. Describe observable changes that occur in the sky, (e.g., clouds forming and moving, the position of the Moon).

4-ESS3 Earth and Human Activity

4-ESS3 Earth and Human Activity

Students who demonstrate understanding can:

4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment. [Clarification Statement: Examples of renewable energy resources could include wind energy, water behind dams, and sunlight; non-renewable energy resources are fossil fuels and fissile materials. Examples of environmental effects could include loss of habitat due to dams, loss of habitat due to surface mining, and air pollution from burning of fossil fuels.]

4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.* [Clarification Statement: Examples of solutions could include designing an earthquake resistant building and improving monitoring of volcanic activity.] [Assessment Boundary: Assessment is limited to earthquakes, floods, tsunamis, and volcanic eruptions.]

Science and Engineering Practices

Obtaining, Evaluating, and Communicating Information

Disciplinary Core Ideas

ESS3.A: Natural Resources

- Energy and fuels that humans use are derived from natural sources,

Crosscutting Concepts

Cause and Effect

- Cause and effect relationships are

SC04-S4C3: Organisms and Environments

Understand the relationships among various organisms and their environment.

PO 1. Describe ways various resources (e.g., air, water, plants, animals, soil) are utilized to meet the needs of a population.

PO 2. Differentiate renewable resources from nonrenewable resources.

PO 3. Analyze the effect that limited resources (e.g., natural gas, minerals) may have on an environment.

PO 4. Describe ways in which resources can be conserved (e.g., by reducing, reusing, recycling, finding substitutes).

constraints of the design solution. (4-ESS3-2)

and research findings is important in engineering. (4-ESS3-1)
Influence of Science, Engineering and

SC04-S3C1: Changes in Environments

Describe the interactions between human populations, natural hazards, and the environment.

PO 1. Describe how natural events and human activities have positive and negative impacts on environments (e.g., fire, floods, pollution, dams).

or develop new ones to increase their benefits, to decrease known risks, and to

SC04-S3C2: Science and Technology in Society

Understand the impact of technology.

PO 2. Describe benefits (e.g., easy communications, rapid transportation) and risks (e.g., pollution, destruction of natural resources) related to the use of technology.

PO 3. Design and construct a technological solution to a common problem or need using common materials.

5-PS1 Matter and Its Interactions

5-PS1 Matter and Its Interactions

Students who demonstrate understanding can:

- 5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen.** [Clarification Statement: Examples of evidence could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water.] [Assessment Boundary: Assessment does not include the atomic-scale mechanism of evaporation and condensation or defining the unseen particles.]
- 5-PS1-2. Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.** [Clarification Statement: Examples of reactions or changes could include phase changes, dissolving, and mixing that forms new substances.] [Assessment Boundary: Assessment does not include distinguishing mass and weight.]
- 5-PS1-3. Make observations and measurements to identify materials based on their properties.** [Clarification Statement: Examples of materials to be identified could include baking soda and other powders, metals, minerals, and liquids. Examples of properties could include color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, and solubility; density is not intended as an identifiable property.] [Assessment Boundary: Assessment does not include density or distinguishing mass and weight.]
- 5-PS1-4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances.**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Students are able to describe that matter is made of particles too small to be seen through the development of a model. Students develop an understanding of the idea that regardless of the type of change that matter undergoes, the total weight of matter is conserved. Students determine whether the mixing of two or more substances results in new substances.

SC05-S5C1: Properties and Changes of Properties in Matter

Understand physical and chemical properties of matter.

PO 1. Identify that matter is made of smaller units called:

- molecules (e.g., H_2O , CO_2)
- atoms (e.g., H, N, Na)

PO 2. Distinguish between mixtures and compounds.

PO 3. Describe changes of matter:

- physical – cutting wood, ripping paper, freezing water
- chemical – burning of wood, rusting of iron, milk turning sour

MS-ESS1 Earth's Place in the Universe

MS-ESS1 Earth's Place in the Universe

Students who demonstrate understanding can:

- MS-ESS1-1. Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.** [Clarification Statement: Examples of models can be physical, graphical, or conceptual.]
- MS-ESS1-2. Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.** [Clarification Statement: Emphasis for the model is on gravity as the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them. Examples of models can be physical (such as the analogy of distance along a football field or computer visualizations of elliptical orbits) or conceptual (such as mathematical proportions relative to the size of familiar objects such as their school or state).] [Assessment Boundary: Assessment does not include Kepler's Laws of orbital motion or the apparent retrograde motion of the planets as viewed from Earth.]
- MS-ESS1-3. Analyze and interpret data to determine scale properties of objects in the solar system.** [Clarification Statement: Emphasis is on the analysis of data from Earth-based instruments, space-based telescopes, and spacecraft to determine similarities and differences among solar system objects. Examples of scale properties include the sizes of an object's layers (such as crust and atmosphere), surface features (such as volcanoes), and orbital radius. Examples of data include statistical information, drawings and photographs, and models.] [Assessment Boundary: Assessment does not include recalling facts about properties of the planets and other solar system bodies.]
- MS-ESS1-4. Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.** [Clarification Statement: Emphasis is on how analyses of rock formations and the fossils they contain are used to establish relative ages of major events in Earth's history. Examples of Earth's major events could range from being very recent (such as the last Ice Age or the earliest fossils of homo sapiens) to very old (such as the formation of Earth or the earliest evidence of life). Examples can include the formation of mountain chains and ocean basins, the evolution or extinction of particular living organisms, or significant volcanic eruptions.] [Assessment Boundary: Assessment does not include recalling the names of specific periods or epochs and events within them.]

SC07-S6C3: Earth in the Solar System Understand the relationships of the Earth and other objects in the solar system.

PO 1. Explain the phases of the Moon in terms of the relative positions of the Earth, Sun, and Moon.

PO 2. Construct a model for the relative positions of the Earth, Sun, and Moon as they relate to corresponding eclipses.

PO 3. Explain the interrelationship between the Earth's tides and the Moon.

PO 4. Explain the seasons in the Northern and Southern Hemispheres in terms of the tilt of the Earth's axis relative to the Earth's revolution around the Sun.

PO 5. Identify the following major constellations visible (seasonally) from the Northern Hemisphere:
 *Orion *Ursa Major (Great Bear) *Cygnus *Scorpius *Cassiopeia

PO 6. Explain the relationship among common objects in the solar system, galaxy, and the universe.

MS-LS3 Heredity: Inheritance and Variation of Traits

MS-LS3 Heredity: Inheritance and Variation of Traits

Students who demonstrate understanding can:

MS-LS3-1. Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism. [Clarification Statement: Emphasis is on conceptual understanding that changes in genetic material may result in making different proteins.]

[Assessment Boundary: Assessment does not include specific changes at the molecular level, mechanisms for protein synthesis, or specific types of mutations.]

MS-LS3-2. Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation. [Clarification Statement: Emphasis is on using models such as Punnett squares, diagrams, and simulations to describe the cause and effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*.

Science and Engineering Practices

Developing and Using Models

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

- Develop and use a model to describe phenomena. (MS-LS3-1),(MS-LS3-2)

Disciplinary Core Ideas

LS1.B: Growth and Development of Organisms

- Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. (*secondary to MS-LS3-2*)

LS3.A: Inheritance of Traits

- Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual. Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. (MS-LS3-1)
- Variations of inherited traits between parent and offspring arise

Crosscutting Concepts

Cause and Effect

- Cause and effect relationships may be used to predict phenomena in natural systems. (MS-LS3-2)

Structure and Function

- Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts, therefore complex natural and designed structures/systems can be analyzed to determine how they function. (MS-LS3-1)

SC08-S4C2: Reproduction and Heredity Understand the basic principles of heredity.

PO 1. Explain the purposes of cell division:

- growth and repair
- reproduction

PO 2. Explain the basic principles of heredity using the human examples of:

- eye color
- widow's peak
- blood type

PO 3. Distinguish between the nature of dominant and recessive traits in humans.

HS-LS3 Heredity: Inheritance and Variation of Traits

HS-LS3 Heredity: Inheritance and Variation of Traits

Students who demonstrate understanding can:

- HS-LS3-1. Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.** [Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.]
- HS-LS3-2. Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.** [Clarification Statement: Emphasis is on using data to support arguments for the way variation occurs.] [Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.]
- HS-LS3-3. Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.** [Clarification Statement: Emphasis is on the use of mathematics to describe the probability of traits as it relates to genetic and environmental factors in the expression of traits.] [Assessment Boundary: Assessment does not include Hardy-Weinberg calculations.]

The performance expectations above were developed using the following elements from the NRC document, *A Framework for K-12 Science Education*.

SCHS-S4C2: Molecular Basis of Heredity

Understand the molecular basis of heredity and resulting genetic diversity.

PO 1. Analyze the relationships among nucleic acids (DNA, RNA), genes, and chromosomes.

PO 2. Describe the molecular basis of heredity, in viruses and living things, including DNA replication and protein synthesis.

PO 3. Explain how genotypic variation occurs and results in phenotypic diversity.

PO 4. Describe how meiosis and fertilization maintain genetic variation.



**What questions do you
have about the next
steps for Arizona?**

Thank You!

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